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PATENT SPECIFICATION

Convention Date (United States): May 13, 1938.

530,440

Application Date (In United Kingdom): May 11, 1939. No. 14045/39.

Complete Specification Accepted: Dec. 12, 1940.

COMPLETE SPECIFICATION

Method of and Apparatus for Making Dental Radiographs

I, ANDRE DE WEAL, a citizen of the United States of America, of 37—43, 88th Street Jackson Heights, in the City of New York, State of New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My invention relates to a new and improved method of producing substantially correct or true dental radiographs and to novel and improved apparatus by the use of which the method may be practised.

For many years, text book writers and dental radiologists have taught the art that to make an accurate radiograph of a tooth the central X-ray beam must be directed at right angles to the plane which bisects the angle between the film and the longitudinal axis of the tooth as determined from the visible portion of the tooth. Such devices operating in accordance with the aforesaid bisection theory have been extensively used. While the films produced by the use of such devices were considered good, they were not as perfect or satisfactory as desired. For example, if the apparatus were adjusted to give perfect projection of the lower molars, the reproductions of the upper centrals would be elongated; and, if adjusted to give perfect projection of the upper centrals, the reproductions of the lower molars would appear short. These two groups represent the extremes. In either of said cases, the reproductions of other teeth between those extremes were found to be more or less faulty and inaccurate.

I have found that practically all teeth in the maxilla and the lower six anterior teeth usually tilted outwardly and that their length axes, as determined by their crown portions, were by no means at right angles to the occlusal plane. The flatter the vault of the maxilla the greater was the tendency for the roots of the teeth to be tilted. On the other hand, the lower bicuspids and molars either were positioned vertically or were tilted inwardly. I have also found that the axis of the crown portion of a tooth generally was different from the axis of its root portion. I observed that a line drawn through the vertical axis of the visible part of a tooth and one drawn through that part normally covered by tissue and bone formed an angle which together with the inclination of the crown placed the length axis of the root at an angle which generally varied from an average of about 5° to about 16° from perpendicular to a bite block shaped to adapt itself to the occlusal plane. These observations led me to an understanding of the existence of a definite relationship between crown-root angles, the position of the teeth in the maxilla and mandible, and the shape of the mouth. I discovered that the apparatus had to be modified to give a relatively higher and higher pointer inclination, speaking of the upper teeth, as the film is more and more depressed if true reproductions were to be obtained.

It is an object of my invention, therefore, to provide an improved method of making dental radiographs and to provide an improved apparatus by means of which the method may be practised whereby an accurate, true-sized reproduction of any tooth may be readily obtained by any operator of average skill.

It is another object of my invention to provide an improved apparatus for indicating mechanically outside the mouth the paths along which the X-rays should be directed in order to produce accurate reproductions of teeth on the films.

With the above and other objects in view, the invention consists in a method of making a dental radiograph which comprises the holding of a film adjacent the inner face of a tooth, and directing the X-rays on the film along a path deviating, from the path perpendicular to the plane bisecting the angle between the plane of the film and the long axis of the tooth as indicated by the crown of the tooth, by the addition of an angle increasing in size as the long axis of the roots deviates increasingly from the long axis of the crown of the tooth.

Further, the invention consists in apparatus for making a dental radiograph comprising a frame, a pivoted film holder mounted on said frame, a pivoted pointer mounted on said frame, and linkage means connecting said film holder and said pointer which, upon being actuated by the pivoted movement of the film holder causes said pointer to swing in the same direction, said linkage means swinging the pointer through an angle one portion of which is one-half as great as the angular movement of the film holder and the remaining portion of which increases as the angular movement of the film holder increases.

It is another object of my invention to provide improved means for holding the apparatus in a fixed position with respect to the teeth of a patient.

The invention is illustrated in a certain preferred embodiment in the accompanying drawings, wherein:—

Fig. 1 is a side elevational view of an apparatus embodying the principles of my invention;

Fig. 2 is a plan view of the apparatus;

Fig. 3 is a longitudinal sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a perspective view on an enlarged scale of my preferred form of bite block;

Fig. 5 is a sectional view on an enlarged scale taken on the line 5—5 of Fig. 1;

Fig. 6 is a view on an enlarged scale taken on the line 6—6 of Fig. 1;

Fig. 7 is a diagrammatic view illustrating the variation in angular movements of the pointer with respect to angular movements of the film holder and giving certain dimensions that should be followed in making one form of the apparatus; and

Fig. 8 is a diagrammatic view of a tooth illustrating the relation of the long axis of the root to the long axis of its crown and the relation of said axes to a plane perpendicular to the occlusal plane or bite surface of the tooth.

Like characters of reference designate like parts in the several views.

Referring now to Figs. 1 to 6 of the drawings, it will be seen that my improved apparatus comprises an elongated frame made up of two channel-shaped side members 10 and 11 within which a link 12 is slidably positioned. The frame members 10 and 11 terminate in downwardly extending grip portions 10*a* and 11*a*, the space between which is bridged by web portions 10*b* and 11*b* (Fig. 2).

The film holder includes a supporting post 13 the lower end of which is pivotally connected by a pin 14 to the adjacent end of the link 12. A tubular member 15 is adapted to fit snugly over the post 13. The post 13 is provided with a recess 16 adapted to receive the lower edge of a film 17, the upper end of the member 15 being provided with an overhanging portion 18 under which the upper edge of the film may be positioned. The arrangement is such that a film may be readily positioned as shown in Figs. 1 to 3 by curving it slightly and moving it transversely to permit its lower and upper edges to be centrally positioned in the recess 16 and under the portion 18, respectively. A link 19 is provided at its lower end with a hub 20 which is disposed between the side members 10 and 11 on a shaft 21 in the form of a two-part tube-stud screw. The other end of the link 19 extends through a slot in the member 15 (Fig. 3) and into a slot in the post 13 and is pivotally connected to the post by a pin 22.

The lower end of a pointer 23 is positioned between side arms 24 which in turn are positioned between the side frame members 10 and 11. The pointer 23 and the side arms 24 are pivoted on a shaft 25 in the form of a tube-stud screw which is carried by the side members 10 and 11. Depending portions 23*a* of the pointer are connected by a rivet 26 to the side arms 24 thereby preventing any relative movement between said side arms and the pointer which in effect constitute a bell crank. One end of a coiled spring 27 is hooked through an opening in the lower end of the pointer 23, the other end of said spring being secured on a pin 28 carried by the side frame members 10 and 11, said spring tending to pull the pointer in a clockwise direction on the shaft 25. The side arms 24 are positioned between spaced finger members 29 which are pivotally connected at their upper ends to the link 12 by a pin 30. The side arms 24 are pivotally connected by a pin 31 to the members 29.

A bite block 32 is positioned on the frame between the film holder and the pointer. In the arrangement shown the bite block is provided with downwardly extending spaced legs 32*a* which fit into boxes 33, formed as shown in Fig. 5, and secured to the outer side faces of the frame members 10 and 11 by fastening means such as rivets 34. The bite block is provided with a surface 32*b* against which the biting surface of a tooth may bear. The bite block is provided with a vertical surface 32*c* adapted to bear against the outer surface of the crown of a tooth. On the frame opposite the bite block is mounted a saddle-like member 35 which is secured to one of the frame

members, for example the member 10, by means of rivets 36 (Fig. 6). The member 35 is provided with a rib 35*a* which in cross section is rounded, as shown in Fig. 6, the rib being of arcuate form, as best shown in Figs. 1 and 3.

The operation of the apparatus thus far described will be understood best by reference to Fig. 3. When the finger member 29 is drawn toward the grip portions 10*a*, 11*a*, the arms 24 and the pointer 23 are swung counter-clockwise on the shaft 25 against the tension of the spring 27, while at the same time the link 12 is pulled to the right thus pulling the lower end of the film holder to the right and causing it to swing on its pivot 22 in the same direction as the pointer. Upon release of the finger member 29, the film holder and the pointer swing clockwise under the influence of the spring 27.

In preparing to make a radiograph of a tooth, a film 17 is inserted in the film holder, a new or sterilized bite block 32 is slipped into position on the frame, the apparatus is held by the operator by gripping the finger members 10*a*, 11*a* and 29, the thumb of the operator resting on the web portions 10*b*—11*b*, and the film holder is tilted backwardly to the limit of its motion. The forward end of the apparatus is then inserted in the patient's mouth and the bite block 32 and the rib 35*a* of the saddle member are carefully positioned between the upper and lower teeth of the patient with the surface 32*c* of the bite block bearing against the outer surface of the crown of the tooth to be radiographed, the engagement of the bite block between the teeth being effective for holding the apparatus as a whole in position when the operator releases the finger pieces. The spring 27 then causes the film holder and the film to swing in clockwise direction as far as the conformation of the mouth will permit so as to bring the film into as nearly as possible parallel position with respect to the tooth to be radiographed.

In all prior apparatus, the parts operated on the bisection theory, the pointer being parallel to the frame when the film in its holder was positioned at right angles to the frame, the pointer swinging through an angle one-half as great as that of the film holder. Relative positions were obtained, therefore, as follows:—

Film.	Pointer.
0°	0°
15°	7.5°
30°	15°
45°	22.5°
60°	30°

In order to obtain true or accurate images, I found it necessary to start with a fixed correction angle and to add to that correction angle another angle which automatically increases in proportion to the degree the angle between the axes of the root portions and the axes of the crown portions of the teeth increases. I have found that the fixed correction angle should be no less than 5° and no more than 12°, and that the maximum superimposed correction should be no less than 5° and no more than 10°. I have also found that there is a definite relation between the surface 32*b* of the bite block and the fixed correction angle imposed on the pointer. When the latter is within the 5°—12° range noted, the surface 32*b* of the bite block should incline at an angle of 2° to 5° with respect to a plane passing through the intersection of the surfaces 32*b*—32*c* and parallel to the elongated frame. I have obtained highly satisfactory results by inclining the bite surface 32*b* at an angle as aforesaid of 2°, using a fixed correction angle of 9° and a superimposed correction angle proportionately increasing to 7°.

In order to teach those skilled in the art how to construct one form of apparatus embodying the principles of my invention, I have given in Fig. 7 the necessary relative dimensions, angles and locations of pivot centers. The link 12 is not shown. In this view I have used a bite surface inclined at 2°, a fixed correction angle of 9° and a superimposed correction angle proportionately increasing to 7°. The longitudinal axis of the frame is represented by a base plane which passes through the centers of the shaft 21 and pivot pin 14, and if the link 12 and the pivot 30 were shown, said base plane would pass through the pivot 30. The surface of the film 17 when in 0° position is at a right angle to said base plane. In the embodiment illustrated, the axis of the shaft 25 carrying the pointer is positioned .043" below the base plane and the pointer is set at a correction angle of 9° when the film is in 0° position a line passing through the axis of shaft 25 and parallel to the base plane being the 0° position of the pointer. The angular positions of the pointer with respect to the five positions of the film noted are also shown. The extent to which the pointer moves as the film holder moves is arrived at by adding the bisector or one-half of the angular movement of the film holder, the fixed correction angle and the proportionately increasing superimposed correction angle, and is apparent from the following table:

Film position	Bisector	Fixed corrective angle	Increasing corrective angle	Pointer position
0°	0°	9°	0°	9°
15°	7.5°	9°	1.75°	18.25°
30°	15°	9°	3.5°	27.5°
45°	22.5°	9°	5.25°	36.75°
60°	30°	9°	7°	46°

The relation of the long axis of the root of a tooth to the long axis of its crown and the relation of those axes to a plane perpendicular to the occlusal plane is illustrated in Fig. 8, wherein the line *a*—*a* represents a plane perpendicular to the occlusal plane represented by the line *b*—*b*. The line *c*—*c* represents the long axis of the crown and the line *d*—*d* the long axis of the root of the tooth. The fixed corrective angle of from 5° to 12°, stated in the third column of the table as 9° is that angle between the lines *a*—*a* and *c*—*c*. The increasing corrective angle of from 0° to 10°, stated in the fourth column of the table as proportionately increasing from 0° to 7°, is that angle between the lines *c*—*c* and *d*—*d*.

The various parts of the frame, film holder and pointer of my improved apparatus may be made of any suitable materials. For economy in production the flat parts may be stamped of metal of suitable gauge and plated or otherwise treated to give them a finished appearance and make them sanitary by permitting sterilization through boiling, chemical or other means. The bite block may be made of wood, pressed pulp or any other suitable material which does not interfere with the passage of the X-rays.

As a result of the arrangement described, the pointer 23 is a true guide from a practical standpoint as to the position in which the X-ray tube is to be placed. When the X-ray tube is placed in position as indicated by the pointer, the operator is assured that the rays from the tube to the film will be at the proper angle vertically and also horizontally to produce an accurate, true-sized image of the tooth on the film. With the film positioned with respect to the surface 32*b* of the bite block as shown in Fig. 3 the operator is assured that the image of the tooth will be located completely within the margins of the film and in substantially centered position on the film with respect to the vertical. The bite block when made of wood or the like offers little or no interference to the passage of the X-rays through it. The provision of the ledge surface 32*c* on the bite block is an important feature. It forms a definite stop which comes to rest against the anterior tooth surface. It facilitates positioning of the apparatus in a patient's mouth and makes for much greater uniformity of results with special reference to a high degree of uniformity of the location of the edge of the crown in relation to the edge of the film. The spring pressure holding the film against the lingual surface of the teeth cooperates with the pressure of the vertical ledge of the bite block to locate the latter, and through it the entire apparatus, in proper position even with slight bite pressure. The bite block and the saddle ridge 35*a* cooperate to locate the apparatus correctly when one or more teeth are missing or when all the teeth are missing above or below, or both. Even in the latter case X-rays are sometimes made to determine the presence and shape of root fragments.

My improved apparatus is capable of being sterilized quickly and easily. The bite block 32 can be thoroughly and satisfactorily sterilized if the operator desires to subject it to further use. In practice, however, the bite block may be discarded after use on one person and a fresh block inserted. The apparatus is readily inserted into the mouth with a minimum of interference and a minimum of contact with the walls of the mouth. I have found particularly that the contact with the palate is very limited and I am able to get much more satisfactory results including a noticeable reduction or elimination of the common tendency to gagging than can be obtained when the patient is expected to hold the film in position by the pressure of one or more fingers.

My improved apparatus is shown in the drawings in position for use in making an X-ray exposure of an upper tooth. It will be understood that for an exposure of a lower tooth the apparatus as a whole will be inverted without affecting in any way the operation of the device. It will be understood also that if desired the film may be placed upon the holder out of center position transversely thereon if such expedient seems necessary or advisable for the proper positioning of the film with respect to the tooth to be radiographed.

The advantages of my improved apparatus may be summarized as follows:

1. It is simple to use, requires no unusual skill and offers definite economy in time and money because retakes due to improper direction of the X-rays are rare.

2. The consistency or uniformity of angulation is of marked value not only to the dentist who has difficulty in producing good films but becomes of special importance when an area is to be radiographed at intervals, as in orthodontia, in checking on regeneration of bone and similar procedures. In such cases, it is important to know that successive films were made at the same angle without appreciable longitudinal or lateral distortion in the normal mouth. Indeed, if because of abnormal formation or location a tooth does appear distorted, it is a dependable index of the direction and degree of its departure from normal. The films are diagnostic to a degree far beyond that of films made in the usual manner by expert dental radiographers. In this connection it may be mentioned that on different occasions by means of my improved apparatus several exposures were made of the same area of the same patient but by different operators and the films were found to be uniform enough that they could be superimposed one on the other and the image clearly read through them all.

3. As my improved apparatus comes into general use, the consultant who examines referred films will quite definitely know the angle at which they were made and duplicate films may be made for further diagnostic study if required.

4. In some areas, particularly the canine region and the anteriors, the film as heretofore employed was appreciably curved resulting in much distortion. With my improved apparatus the film is held practically flat and distortion is thereby avoided.

5. Heretofore in taking radiographs of the lower incisors not much more than half the film was customarily used. With my improved apparatus all of the film is employed and parts of the osseous structure below the apices can be clearly seen.

6. Dental radiographs made according to prior methods have generally been made at a target film distance of a few inches because it is less difficult to position properly the apparatus and cone when they are close to the patient's face. My improved apparatus permits positioning at much greater distances which results in marked increase of definition and lessening of distortion, the necessarily longer exposure time not being objectionable.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. The method of making a dental radiograph which comprises the holding of a film adjacent the inner face of a tooth, and directing the X-rays on the film along a path deviating, from the path perpendicular to the plane bisecting the angle between the plane of the film and the long axis of the tooth as indicated by the crown of the tooth, by the addition of an angle increasing in size as the long axis of the root deviates increasingly from the long axis of the crown of the tooth.

2. The method of making a dental radiograph according to claim 1, characterized in that the size of said additional angle is increased in constant proportion to increases in the size of the angle between the long axis of the root and that of the crown of the tooth.

3. The method of making a dental radiograph according to claim 1 or 2, characterized in that said addition consists in a corrective angle within the range 5° to 12° to which is added an angle of from 0° to 10°.

4. The method of making a dental radiograph according to claim 1 or 2, characterized in that said addition consists in a corrective angle of about 9° to which is added an angle of from 0° to 7°.

5. The method of making dental radiographs which comprises the holding of the films adjacent the inner faces of the differently positioned teeth, and directing the X-rays on the respective films along paths deviating, from the respective paths perpendicular to the respective planes bisecting the respective angles between the planes of the respective films and the long axes of the teeth as indicated by the crowns of the teeth, by the addition of a corrective angle within the range 5° to 12° and preferably of about 9° to which is added an angle increasing from 0° to 10° as the deflection of the films increases from a position of 0° to a position of 60° with respect to a plane perpendicular to the occlusal plane.

6. Apparatus for making a dental radiograph comprising a frame, a pivoted film holder mounted on said frame, a pivoted pointer mounted on said frame, and linkage means connecting said film holder and said pointer which upon being actuated by the pivoted movement of the film holder causes said pointer to swing in the same direction, said linkage means swinging the pointer through an angle one portion of which is one-half as great as the angular movement of the film

holder and the remaining portion of which increases as the angular movement of the film holder increases.

7. Apparatus for making a dental radiograph comprising a frame, a pivoted film holder mounted on said frame, a pivoted pointer mounted on said frame, and linkage means connecting said film holder and said pointer which upon being actuated by the pivoted movement of the film holder causes said pointer to swing in the same direction said linkage means swinging the pointer through an angle one portion of which is one-half as great as the angular movement of the film holder and the remaining portion of which inclination of the film holder is increased in constant proportion to increases in the angle of inclination of the film holder.

8. Apparatus for making a dental radiograph according to claim 6 or 7, in which said linkage means comprises a link pivoted at one end to said frame and at the other end to the film holder, a second link slidably carried by the frame and pivoted to the film holder, a bell crank pivoted to the frame one arm of which serves as the pointer and a member pivoted at one end to said second link and at its other end to the other arm of the bell crank, whereby swinging movement of the film holder causes the pointer to swing in the same direction, the centers of said pivotal connections being such that the pointer swings through the angle stated.

9. Apparatus for making a dental radiograph according to claim 6, 7 or 8, in which the remaining portion of said angle is a fixed corrective angle within the range 5° to 12° to which is added an angle which is increased from 0° to 10° as the angles of inclination of the film holder increase from 0° to about 60° with respect to a plane perpendicular to the occlusal plane.

10. Apparatus for making a dental radiograph according to claim 6, 7 or 8, in which the remaining portion of said angle is a corrective angle which is increased from about 9° to about 16° in substantially constant proportion to increases in the angle of inclination of the film holder from 0° to about 60° with respect to a plane perpendicular to the occlusal plane.

11. Apparatus for making a dental radiograph according to any of claims 6 to 10, which includes a bite block mounted on the frame for fixing the position of the frame with respect to a tooth being radiographed.

12. Apparatus for making a dental radiograph according to any of claims 6 to 10 and 11, in which the frame is elongated, the film holder being mounted at one end of the frame, the pointer at the other end thereof, and the bite block being mounted on said frame between the film holder and the pointer.

13. Apparatus for making a dental radiograph according to claim 11 or 12, in which the bite block has a surface extending vertically and bearing against the outer side of the crown of the tooth and a further or biting surface against which the bite surface of the tooth bears.

14. Apparatus for making a dental radiograph according to claim 13, in which said further surface is inclined preferably at an angle of from 92° to 95°, with respect to the first named surface.

15. Apparatus for making a dental radiograph according to claim 13, in which said biting surface is at such inclination that when a film in the film holder is positioned substantially perpendicular to the occlusal plane the angle between said surface and the film is from 2° to 5° less than 90°.

16. Apparatus for making a dental radiograph according to any of claims 11 to 15, which includes an arcuate substantially rigid saddle member on the frame opposite the bite block against which the tooth or gum opposite the first mentioned tooth bears.

17. The method of making a dental radiograph substantially as hereinbefore described.

18. Apparatus for making a dental radiograph substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 11th day of May, 1939.

MARKS & CLERK.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1941.

530,440 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

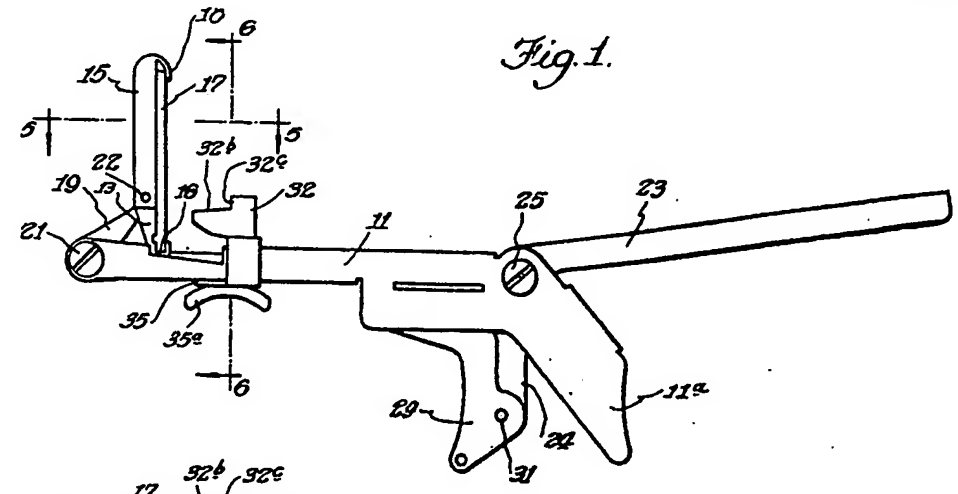

Fig. 2.

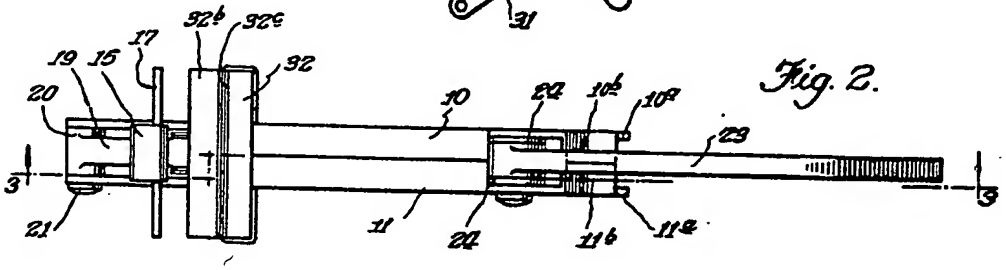

Fig. 3.

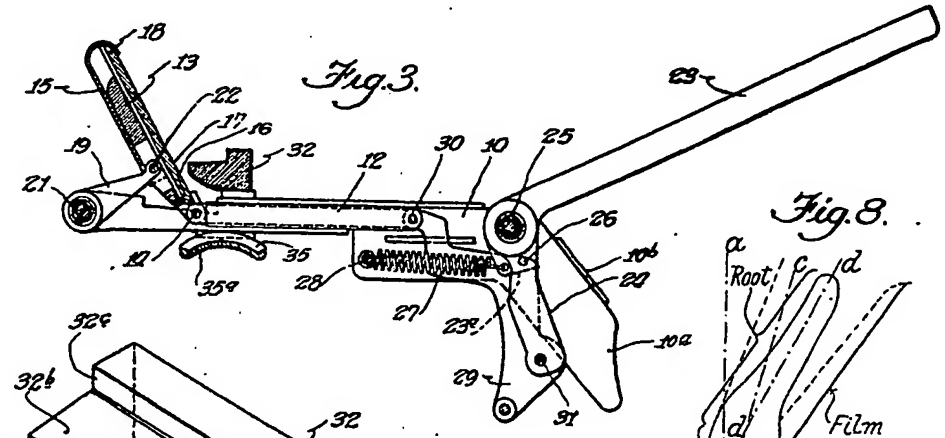

Fig. 4.

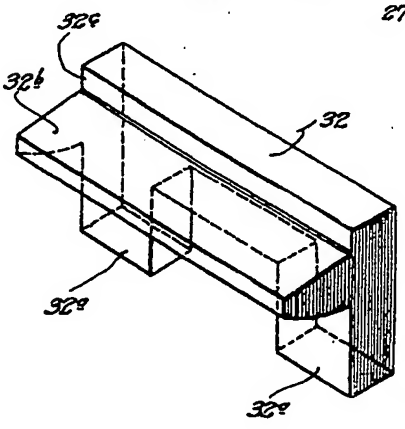

Fig. 8.

2 SHEETS

SHEET 1

SHEET 2

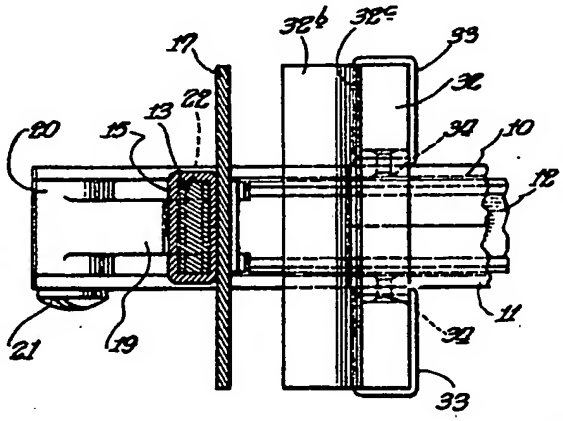

Fig. 5

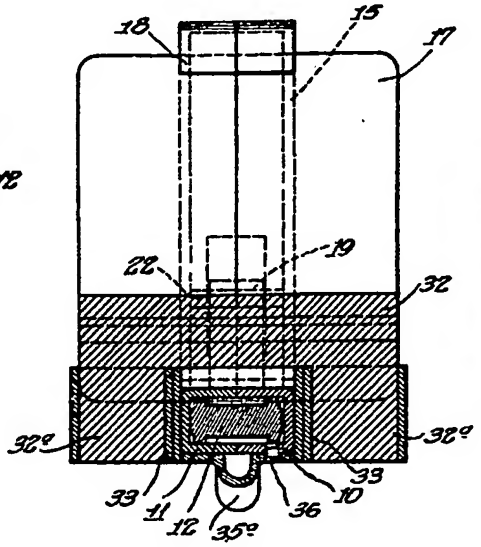

Fig. 6

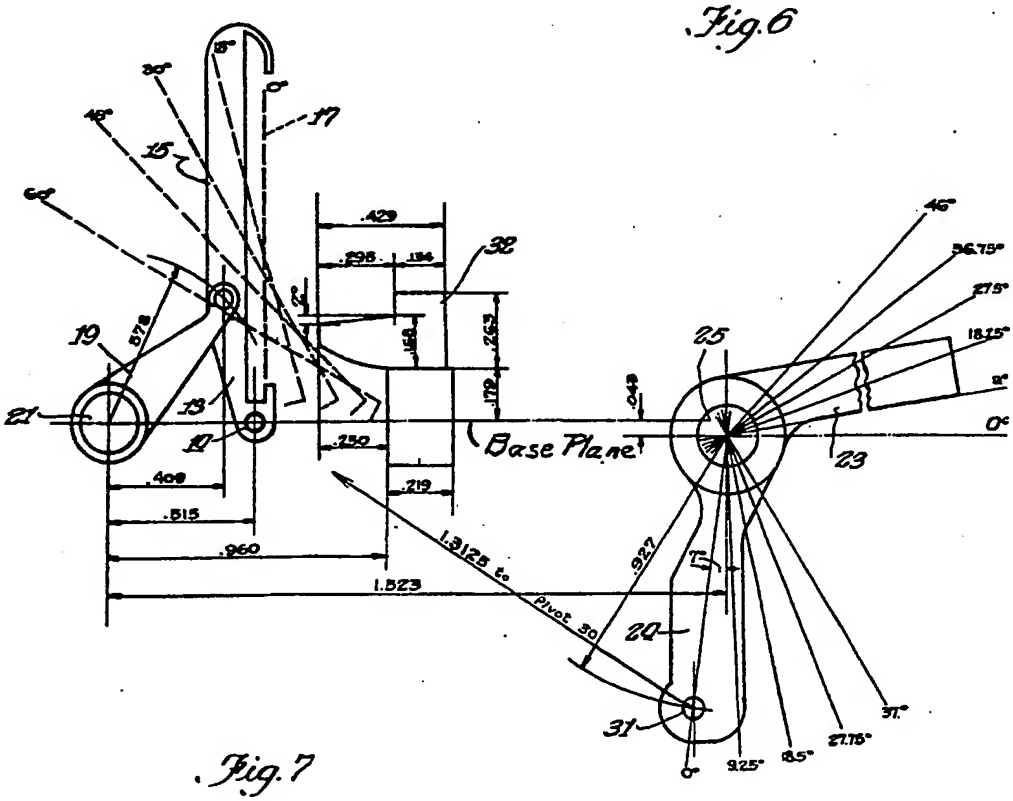

Fig. 7

530,440 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale]

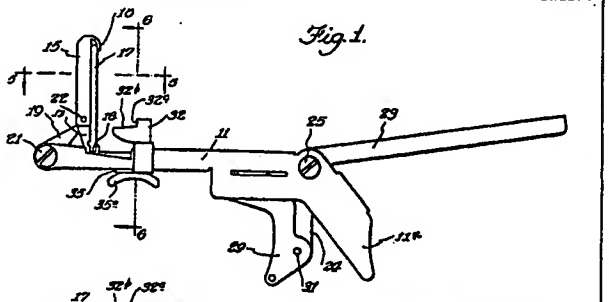

Fig. 1.

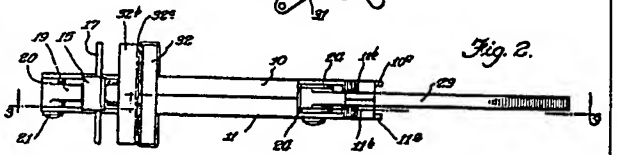

Fig. 2.

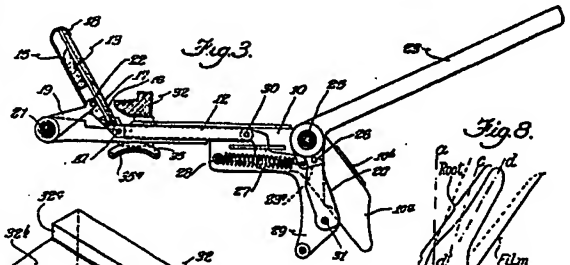

Fig. 3.

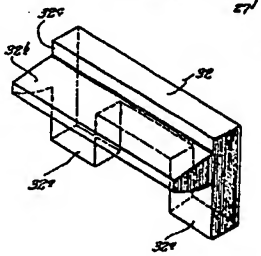

Fig. 4.

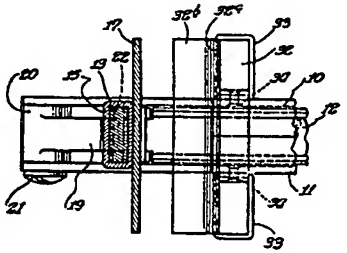

Fig. 5.

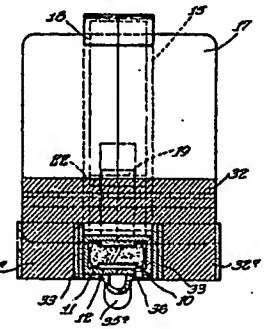

Fig. 6.

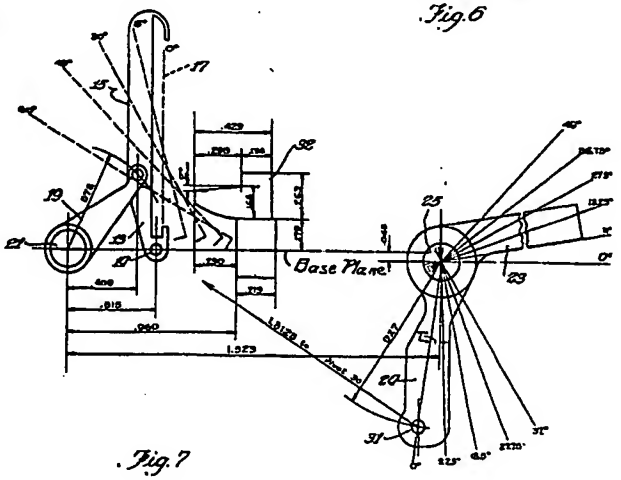

Fig. 7.

Fig. 8.

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